CO 3.2 Track Correlation Management Services Functional Requirements

Track Correlation Management Services (TCMS) functional requirements are focused on two goals: integrating contact data based upon discrete and continuous attribute information to create and maintain a valid and timely track database (Tdb), and support management of a common operational picture based on an allocation of data management responsibilities to organizations across a theater of operations. This section defines the system requirements to achieve both goals.

Note that the Track Correlation Management Services (or System) is referred to simply as "system" in the following requirements.

CO 3.2.1 Data Representation Functional Requirements

3.2.1.1 The Tdb **shall** contain both contact and track data. This track and contact data **shall** be accessible in terms of related entities (e.g., aircraft, ships, land force units) and in terms of technical collection domains (e.g. ELINT, COMINT, ...). The Tdb will also contain associations between tracks and entities. (The mechanisms and internal data structures for implementation are not dictated in this SRS, nor are the number of contacts or tracks to be allocated.)

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3.2.1.2 The system **shall** be capable of maintaining integrity of tracks within technical collection domains.

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3.2.1.3 Identifying attributes and related information maintained for each of the Tdb tracks **shall** be based on that information needed to support the correlation processing requirements and to support display requirements, i.e. display symbol identification, location, and annotation.

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3.2.1.4 The TDB **shall** support representation of unit echelon and type (i.e. armored cavalry), and support association of units to represent aggregation into higher echelon forces.

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3.2.1.5 Aggregated force representations **shall** include representation of the center of mass of the force and command post locations when known.

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3.2.1.6 Associations between entities and tracks are intended to represent the results of a data fusion process and analysis. Associations, once established, **shall** also be capable of being broken (disassociated) in the event that contravening information becomes available.

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3.2.1.7 The Tdb **shall** support the control of the visibility of each track across a LAN or WAN (referred to in this SRS as scope). A given track may be visible only at a given workstation on a LAN (terminal tracks), at all workstations on a local area network (local tracks), or be a candidate for transmission on a WAN (WAN tracks). The system **shall** support the assignment of track scope, and a mechanism for manually modifying the scope of a given track.

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3.2.1.8 The Tdb **shall** support the designation of each record as either real world, live training (occurs when a friendly unit simulates a different object during a training exercise), and simulated (contact reports that are artificially injected into the system). Live training tracks **shall** be promotable to real world (with the required attribute changes) at the end of a training exercise.

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3.2.1.9 The Tdb **shall** contain the most current attribute information for each track together with additional fields related to the track. The Tdb **shall** store all reports into the track's report history, but the track's report history may be limited to the most recent report events if required for disk management.

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The size of archived track history may vary according to track characteristics. For example, there may be no requirement to archive unidentified TADIL track histories owing to the real time nature of the data source.

3.2.1.10 The Tdb **shall** support a scaleable, distributed environment across a LAN/WAN, be capable of maintaining a master Tdb for the network, and provide access to Tdb information across the LAN/WAN.

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3.2.1.11 The system **shall** support the assignment to each track object of a unique identification (UID) key field that is guaranteed to be unique across the worldwide DII.

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CO 3.2.2 Correlation Service

The system **shall** provide the capability to automatically correlate incoming reports to existing tracks, originate new tracks when necessary, or originate ambiguities if correlation leads to anomaly. At a minimum, the system provides two types of correlation processing:

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- Attribute correlation, wherein correlation decisions are based primarily on matching data fields with discrete valid values.

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- Statistical correlation, which is applied in case the contact report contains useful continuous parameters characteristic of the entity being observed, but which contains insufficient discrete attributes for successful attribute matching.

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This section specifies requirements for each type of processing, and how they should interact. It is organized along a model of data flow throughout the system with subsections devoted to data input and storage, data alignment, database update, correlation decision making, and data merging.

CO 3.2.2.1 Data Input Interface and Storage

3.2.2.1.1 This system **shall** provide common APIs to accept contact data from other COE segments such as the Communications Services and Mission Applications.

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3.2.2.1.2 The system **shall** support the encoding and decoding of high volume binary data streams to include TADIL A, B, J, and other high data rate inputs. This requirement is necessary to achieve the required throughput.

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3.2.2.1.3 The system **shall** support the back-up and restoration of track histories by archiving track information. This capability **shall** provide track information during disk failure and system upgrades. The system **shall** preserve the data event by event. A batch update may result in data loss during system failure. The system **shall** down-sample high data rate inputs to ensure viable storage volumes.

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CO 3.2.2.2 Data Alignment

3.2.2.2.1 The system **shall** screen incoming contact reports for duplicate reporting and delete all contacts found to be an exact match to a previous report based upon attributes specified in a contact duplication table. (Note that this action could also occur at any time before the Tdb is updated and is not specified to occur in the data alignment phase.) Duplicate screening shall account for differences in reported precision, retaining the most precise information when duplicates are detected.

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3.2.2.2.2 The system **shall** validate and normalize incoming data and prioritize for subsequent processing.

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3.2.2.2.3 Data normalization **shall** include renormalizing error ellipse to a standard confidence factor, and synonym aliasing where appropriate.

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3.2.2.2.4 The system **shall** provide a data filtering capability on input based on operator specified criterion to either explicitly include or exclude contact reports from being further processed. The criterion **shall** include geographic location, timeliness, and other information (which may be collection domain specific) that is either explicitly reported in the incoming contact report information or implicit based on the reported information.

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CO 3.2.2.3 Distributed Data Management Functional Requirements

3.2.2.3.1 To support a Common Operational Picture (COP), the system **shall** support an allocation of data management responsibility by supporting the following modes of operation:

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- Coordinator Mode - wherein a network node has been designated the responsible producer for compiling and maintaining a portion of the overall track database (e.g., based on geographic area, category, threat, track type) and reporting it in the form of track management directives both up echelon and to subordinate units.

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- Participant Mode - wherein it can accept the received track management directives of a coordinator to faithfully replicate the portion of the overall tactical picture.

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- Independent Mode - wherein all necessary processing is performed at that system installation, without any received track management directives from any other processes.

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This capability permits the system to function across a wide area network (WAN) as a participant in multiple coordinator's networks simultaneously, with the objective of integrating components of the overall consistent track database reported by those coordinators in accordance with the allocation of track management responsibilities (e.g., allocation of maintenance of the air, ground, and maritime components of the overall track database to the appropriate components, and / or, further allocating track management responsibilities based on geographic regions or other means). It follows that the system must be configurable to recognize authoritative external track management directives.

3.2.2.3.2 The system **shall** include the capability to allow the coordinator to issue track management directives which add, remove, and modify information in a participant's track database (e.g., change a previously reported identity from "Unit XYZ" to "Unknown" or a null / no statement value).

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3.2.2.3.3 The system **shall** be capable of respecting track management directives from locally installed integrated mission applications which inject track data into the system (e.g., via standard APIs). Thus, a mission application can function as a virtual track coordinator for a designated subset of the track database.

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3.2.2.3.4 In either the coordinator, participant, or multiple participant modes of operation described above, the system **shall** also be capable of integrating additional source data into the track database based on local information sources and injecting it in a manner consistent with the operating mode. (Note that the operating modes described above are not mutually exclusive. For example, the system may serve as a coordinator for a portion of the track database, while simultaneously functioning as a participant to multiple other coordinators to obtain their contributions to the overall theater tactical picture, as well as maintaining an independent view of selected portions of the track database.)

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CO 3.2.2.4 Correlation Processing

3.2.2.4.1 The system **shall** support routing of incoming data to the appropriate correlation processes. These processes **shall** include (but are not restricted to): discrete attributes, ELINT, COMINT, ACINT, GMTI, and others. The system **shall** be capable of directly updating the Track DB based upon received track management directives (e.g., receive track number, delete track, merge track), as well

as maintaining an independent view of the data regardless of the system's operating mode (i.e., coordinator, participant, independent).

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3.2.2.4.2 Whenever an incoming contact report contains data applicable to multiple correlation processes, the report **shall** be processed by each process. Decision rules **shall** be provided to resolve conflicts in the outcome of these multiple correlation processes. For example, a report that contains both unique attribute information and emitter parametric data **shall** be processed by both the attribute correlator and the ELINT correlator.

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3.2.2.4.3 Attribute track correlation **shall** include feasibility checks, to include motion feasibility checks for moving targets and geographic tests for fixed targets. Feasibility tests **shall** include screening based upon category (land, naval, air, sub, etc.) and threat (friend, hostile, unknown, etc.) with a specified set of allowed and disallowed transitions.

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3.2.2.4.4 Attribute matching **shall** be performed on a hierarchical basis to provide more reliance on higher confidence attributes and track continuity indicators, and inhibit inconsistencies in lower confidence attributes from preventing correlation in the presence of matching higher confidence information.

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3.2.2.4.5 When updating Tdb objects based on correlation results, attribute information **shall** normally be treated as additive, with reported information being added to an object if not previously available but not over writing previously reported values so as to avoid allowing inconsistent reporting sources to incorrectly alter values in the Tdb. The exception to this additive update approach **shall** be the case of operating in participant mode wherein all updates from a coordinator will be treated on an over write basis, faithfully representing the coordinator's management of the subset of the overall tactical picture allocated to it.

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3.2.2.4.6 Previously declared ambiguities **shall** be reprocessed on a periodic or event basis to attempt resolution.

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3.2.2.4.7 Tdb management processing **shall** be configurable to automatically purge unassociated track objects based on specified auto purge criterion.

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3.2.2.4.8 The system **shall** support the ability to associate tracks in the Tdb with entities within the Modernized Intelligence Database (MIDB). Processing of contacts **shall** be able to consider MIDB entities in the candidate selection process, where appropriate (such as SIGINT reporting).

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3.2.2.4.9 The system **shall** not permit the correlation of contact reports with different scope or reality attributes. See sections 3.2.1.7 and 3.2.1.8.

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CO 3.2.2.4.10 ELINT Domain Processing

3.2.2.4.10.1 ELINT correlation **shall** be capable of exploiting apriori information about signal characteristics when available, but **shall** not be dependent on apriori information so as to be capable of processing unidentified reports or data about which little apriori information is available.

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3.2.2.4.10.2 The ELINT correlation process includes assembling a set of tracks that are update candidates. Candidates **shall** be initially gathered based on matching or equivalent ELINT Notations (ELNOTs) or signal identification. In general, a precise match **shall** not be required except for cases where high confidence signal identifications are available. Multiple reported ELNOTs **shall** also be considered if contained in the incoming report.

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3.2.2.4.10.3 ELINT candidates with matching or equivalent ELNOT or signal identifications **shall** be tested for motion or geographic feasibility, and for parameter feasibility.

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3.2.2.4.10.4 ELINT correlation **shall** support Identification / re-identification processing to deal with known inconsistencies in reported ELNOT / signal identification data or unidentified reports.

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3.2.2.4.10.5 For statistical correlation, the parameter feasibility screening (as well as all subsequent parameter processing) **shall** include explicit consideration of the accuracy of available parameter information, either explicitly reported by the information source or inferred based on the reporting source capabilities.

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3.2.2.4.10.6 Candidates **shall** also be screened based on disregard time criteria. In processing both PRI and Scan information, baseband processing **shall** be applied.

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3.2.2.4.10.7 Scoring and decision processing includes the actual evaluation of the reported parameter and geographic information against that contained in the candidate tracks. Reported parameter information (after basebanding) together with parameter stability / uncertainty information (reported or inferred) **shall** be scored against the estimated mean and estimated standard deviation (tolerance) for each parameter in each candidate ELINT track, and combined to form an overall parameter score for each candidate track.

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3.2.2.4.10.8 The combination process **shall** include provisions for non-homogeneous overlap in parameters with different candidates (i.e. the common parameters between candidate “a” versus the report will not necessarily be identical to the common parameters between candidate “b” and the report).

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3.2.2.4.10.9 Reported geographic information in the form of either an ellipse area of uncertainty at a specified containment percentage, or a line of bearing report and bearing uncertainty at a specified percentage

containment **shall** be scored against the geographic information in the candidate track to form a geographic score.

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3.2.2.4.10.10 In those cases where an emitter track is associated to a higher level tactical object, the geographic information for the higher level object **shall** be used for scoring (and all other geographic processing as well) since it represents the union of all geographic information available from all sources, not just geographic information available based on reports of that single emitter.

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3.2.2.4.10.11 The geographic score and parameter score for each candidate track **shall** be combined into an overall score again using a self adaptive weighting process, and a decision made between updating one of the candidates, creating a new track object, or declaring an ambiguity based on an optimized minimum risk / cost of error criterion.

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3.2.2.4.10.12 The system **shall** provide a site templating capability to support aggregation of ELINT track objects associated with a common function or mission.

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3.2.2.4.10.13 Land based mobile ELINT processing **shall** also consider equipment breakdown and setup times in determining if an emitter has relocated

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CO 3.2.2.4.11 TADIL Domain Processing

3.2.2.4.11.1 The system **shall** be capable of simultaneously accepting an input from multiple TADIL sources to include both their updates and management directives, and replicating the TADIL tactical picture within the Tdb. The system **shall** be capable of accepting inputs from TADIL A, TADIL B, and TADIL J.

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3.2.2.4.11.2 Correlation processing of TADIL data **shall** be focused on faithfully replicating the received track picture, and supporting it's integration within the overall tactical picture through association of TADIL tracks with higher level tactical object tracks.

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3.2.2.4.11.3 The system **shall** be configurable to perform auto purge of Tdb contents and eliminate TADIL tracks which have ceased being reported.

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3.2.2.4.11.4 TADIL processing **shall** be based primarily on received track numbers and management directives, but **shall** also include a secondary correlation scheme to reassociate data in the event that the link goes down and rapidly is reestablished, to automate the reassociation of TADIL tracks whenever possible in spite of block changes in TADIL track numbers associated with the link going down and back up.

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3.2.2.4.11.5 Automatic association of TADIL tracks via PIF attribute matching **shall** be supported.
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CO 3.2.2.4.12 COMINT Domain Processing

CO 3.2.2.4.13 ACINT Domain Processing

CO 3.2.2.4.14 MTI Domain Processing

CO 3.2.2.5 Data Merging

3.2.2.5.1 The system **shall** support the association and disassociation of reporting domain level track objects to primary high-level tracks. In this state, lower-level tracks continue to exist and are subject to continued updating by the appropriate correlation process, but the high-level track history represents the union of the histories of its lower-level tracks.
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3.2.2.5.2 The system **shall** support the association of multiple low-level tracks to a single high-level track. For example, one of the lower-level tracks may be a Link track, another an ELINT track and a third a GMTI track. The system **shall** support the distribution of these high-low track relationships across a wide area network in order to maintain a common joint perspective.
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3.2.2.5.3 Attributes not present in a high-level track **shall** be inherited from a low-level track. The high-level track's attribute **shall** prevail if there are conflicting values between a high-level and a low-level track. The system **shall** allow separation of associated tracks, with inherited attributes of each remaining after the separation.
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3.2.2.5.4 The system **shall** support an Entity to Emitter Association database. The system **shall** support the addition, deletion and editing of data which lists particular emitters known to be associated with specific entities. The entity information **shall** consist of attributes such as entity name, entity class, entity type, entity identifying number, flag and entity control number. The emitter information **shall** include information such as the emitter name, ELNOT, and observed operating ranges for PRI, SCAN and RF.
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3.2.2.5.5 The system **shall** include an automated capability to evaluate time position histories of similar and dissimilar (e.g. ELINT & Platform, ELINT & TADIL, COMINT & ELINT) source moving track objects, screen the available explicit or inferred attribute information on those track objects, and recommend associations of similar and dissimilar source tracks based on absence of conflicting attributes and the presence of unambiguous and statistically significant degrees of correspondence in the time position histories.
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3.2.2.5.6 If a single contact report is subject to multiple correlation processes, and is simultaneously matched with a high level track/entity and a lower level track, and no attribute conflicts result, then automatic association **shall** occur.

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3.2.2.5.7 The system **shall** allow the merging of two tracks with non conflicting attributes into a single track record with a combined track history. In this case the two tracks lose their individual identity.

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